Case-studies or suitcases: Addressing graduate attributes with an airline management simulation

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The graduate attributes of critical thinking and creativity sought by prospective employers are not easily achieved through passive observation of subject content, and its replay in assessment tasks that encourage rote learning. Simulations allow active learning to play a constructive role in student outcomes, providing opportunities to test, reflect on, and adapt the subject content. Where the simulation and assessment tasks are aligned with the desired learning outcomes students will be more engaged with their learning and are more likely to develop career relevant attributes. This paper addresses the introduction of a web-based airline business simulation to a 3rd year undergraduate aviation course.

Keywords: simulations, experiential learning, aviation, graduate attributes.

Introduction

This paper reviews the introduction of a web-based aviation simulation to a 3rd year undergraduate course. Airline Management is a core unit in the undergraduate aviation degree, and is undertaken by both pilot trainees and management students. It aims to integrate and consolidate earlier industry-specific learning and contribute to the development of work-ready graduates. Students are exposed to practical airline fleet and network management problems though coursework, industry guests, and assessment tasks linked to current industry issues.

In the first semester of 2008, the subject was revised to align student learning more closely with graduate attributes sought by employers. In implementing this review the opportunity was taken to address the learning tools employed, and to replace several instruction and assessment components with a competitive airline business simulation. Introduction of the simulation was supported with online tutorials, an online instruction manual, and an introductory lecture on the 'functional' elements of the simulation. Tutorial exercises were developed to rapidly integrate the simulation with the subject content and objectives.

Support for teaching and learning simulations is not universal, but is more generally supported where the target group's characteristics are suited and the simulation is sufficiently realistic. (Porter et al 2004, Kluge 2007). Given that the class is industry specific and forms part of a vocational degree there was a case to consider including an industry specific simulation. Further, as the literature indicates that there is relatively poorer learning from passive exposure to subject material, that deep learning requires engagement, and that active learning engages students in a cognitive process likely to produce transferable knowledge and skills, there was a solid basis for the introduction of a relevant simulation. The simulation is in its turn aligned with the desired student outcomes and industry specified graduate attributes.

Enhanced learning using simulations

Simulation is used extensively in aviation training, particularly for pilots, cabin crew, and engineers. These simulations often address the development of cognitive-motor skills where the subject is required to perform 'non-trivial computations on incoming data and execute some relatively complex motor response' (Matthews et al 2000). Management simulations take a different path, looking to engage students more deeply with management problems than can be achieved in a traditional case study approach. A body of research supports the use of simulations over case teaching in general management, and as personal computing and web-based resources have become more powerful, online management simulations have become more widespread. Faria and Nulsen (1996), Wolfe (1997), Wolfe and Luethge (2003) identify ample evidence that computer-based general management games are effective for teaching management, and that when the outcomes of games are compared with case-based teaching, games produce superior knowledge gains.

In developing instructional design for higher education, Kehoe (2007) brings the theory of memory and cognition to the table, identifying the objective of facilitating the learning of knowledge, skills and attitudes (KSA). Learning opportunities are constant, and can range from casual exchanges between friends to formalised lectures or training. Importantly Kehoe notes that rote (surface) reproduction of KSAs in practical environments is rarely effective, and that an individual's ability to transfer learning from one situation to another is 'essential to the practical use of adult learning'. The human cognitive architecture that underpins formal and informal adult learning includes:

- *conditions of learning*: instructional material and conditions encountered
- *encoding stage*: use and filtering of incoming material
- *memory*: both the development of basic rules/scripts/word associations, and the higher order mental models and schemas into which humans can incorporate new KSA
- *constructive processes*: existing schemas influence the encoding of new information received
- *feedback*: internal, external and artificial feedback, proficiency as the task is repeated
- *retrieval*: transfer of learning as the learners retrieve KSAs from their long-term memory and combine them as required to deal with each situation.

The airline simulation (through its cyclic nature) was expected to bring benefits in the memory, constructive process and feedback stages of this model. Similar cyclic approaches are found in the learn-forget-relearn cycle (Davidovitcha et al 2008, Parush et al 2002) and the experiential learning cycle (Kolb 1984) where students test, observe, and reflect on the results of the simulation over a 9-week cycle, allowing them to pass several times through the stages of

- experience
- observation and reflection
- abstract conceptualisation
- testing of concepts in new situations

Parush et al (2002) identified a significant learning benefit from allowing students to revisit the history of the simulation and restart at any point. While this is unachievable within an integrated competitive simulation, the opportunity was taken to allow trial runs that could be wound back before the simulation began in earnest. This 'pre-learning' allowed teams to identify significant management problems that had been deliberately built into each airline's set up. The simulation was expected to create heightened interest and engagement for students with its direct relevance to the aviation industry and use of industry terms and jargon. In building the start position, contemporary economic and aircraft operational issues such as fleet age, maintenance scheduling, airport capacity, fuel price, and low cost carrier competition were factored into the simulation structure.

Competencies and knowledge likely to be developed from the simulation are consistent with the desired graduate attributes identified UNSW Aviation's industry advisory committee. Industry specific skills and familiarities that are developed join the generic graduate attributes of critical thinking, creativity, ability to work in groups, and scholarly enquiry, in the prospective learning outcomes.

Active learning of this nature requires students to use higher order thinking skills, not simply to passively observe and note the lecture material provided. Snyder (2005) identifies analysis, synthesis and evaluation as higher order skills engaged in active learning. The opportunity for engagement with the subject increases where substantial control of the learning task can be moved to the students. Where some competitive element is included, the level of engagement arguably increases again, and this competitive interest was observed in student group behaviour. Student input to the simulation over a series of weekly decisions allows an understanding to develop, not only of WHAT airlines do in the fleet and airline planning process, but HOW and WHY they do it as competitive pressures intensify, costs rise, and markets evolve.

Biggs (1999) theory of constructive alignment identifies the importance of getting students to take responsibility for their own learning. Teachers are challenged to design learning and assessment activities that are 'constructively aligned' with the intended learning outcomes. Treleavan and Voola (2008) identify the importance of students seeing the relevance of their studies to future career objectives. The inclusion of a simulation that not only encompasses the subject content, but also provides opportunities to repeatedly test the practical components subject theory in both learning and assessment tasks meets this challenge.

Practical limitations

In an environment where teaching effectiveness is largely judged by student survey results, a degree of risk accompanies the implementation of experiential learning tools that require a higher level of both student and teacher engagement. Familiarising students with a simulation takes precious teaching time out of already tight semesters, and effectively requires an investment of time in technical learning to enable higher-level subject content learning to follow. With these constraints, a teaching simulation must balance the need for sufficient complexity and reality to engage and challenge the students, without requiring excessive time for training or familiarisation. Offsetting this is the high level of student familiarity with online activity, where the web has become a common environment

As noted earlier, aviation training and education has used increasingly sophisticated simulation over many years, with highly realistic simulations used extensively in flight crew and engineering training. This significant reliance on simulation reduces cost, allows unusual (and sometimes risky) situations to be tested by students, and facilitates observation and abstract conceptualisation as learning tools. Approximately one third of the class undertaking the management simulation had already experienced flight simulator training in earlier stages of their studies. Small software problems and inconsistencies within the simulation caused some student frustration. These minor problems were addressed with the software provider and responses were shared with all students.

The airline simulation selected offers animated tutorials, help screens, and an online user manual. To reduce early complexity, the 12 student groups started the simulation with pre-loaded airlines complete with a fleet of aircraft, adequate funding, and an operating base. Each airline however faced at least one immediate challenge in fleet management that the groups had to identify during a trial decision round. These challenges included fragmented fleet structures, aircraft overdue for heavy maintenance, or airport resource limits. Simulated airline networks were geographically limited to key cities in Europe and Asia to minimise complexity, and mandatory core routes were specified to ensure an immediate competitive market. After the trial decision was processed to allow students to familiarise themselves with the software, the simulation was reset. Student groups completed 8 live decisions, engaged in bilateral negotiations with potential partner airlines, and completed a 3-year business plan as components of the subject. Simulation tasks contributed 35% of the total subject assessment.

Research methodology

In this study, the key questions are:

1. did the simulation increase student engagement with the subject?
2. were the required graduate attributes developed more effectively?

An online Course and Teaching Evaluation and Improvement survey (CATEI) is provided for all subjects at UNSW. Student response levels, even with significant prompting are low. To supplement the CATEI surveys a paper-based subject survey (with additional questions targeted at the simulation) was administered two weeks before the end of the semester.

To assure students of anonymity and ensure that the results of the survey could not impact student grades, the survey was administered and collected by members of the UNSW Aviation Society, and the survey forms held aside until final results were released. The survey provided a 5 point scale scored from strongly disagree (0), disagree (1) neutral (2) agree (3) to strongly agree (4) for 15 questions. Eight questions addressed standard teaching and learning evaluation criteria, while the 6 additional questions directly addressed the use of the simulation in the course. Simulation factors considered included:

- learning (question 9 the simulation helped me understand the subject)
- process (question 10 the simulation was too complex for a class at this level)
- balance (question 13 the simulation should form a larger part of the assessment, and question 14 I would prefer the subject to be taught without an online simulation.)

The remaining questions addressed group participation and the quality of support materials. Open-ended questions encouraged more extensive feedback by asking students to identify ‘the thing I liked most …’ and ‘if I could change one thing I would ...’

From the class of 72 students, 38 valid surveys were returned, against a 35% response rate for the online survey. Comparisons using CATEI surveys for the subject since 2006 were made, but the strength of the comparisons was greatly diminished by organisational changes that saw the survey move from paper-based (56% response) to online (35% response), the scoring scale values change from 4 to 6, as well as the class size increasing by 25%, many of whom are studying part-time against an all full time response the 2006 survey. These inconsistencies are recognised as limiting the usability of the results.

Results

The following hypotheses were tested.

1. Students would identify a positive engagement with the subject
2. Perceived development of key graduate attributes would improve
3. Survey ratings for subject administration factors would deteriorate

In hypothesis 3 it was anticipated that student survey results would deteriorate as a consequence of the risk factors accompanying a major subject revision and the introduction of the simulation. Some uncertainty around assessment tasks not previously encountered, greater reliance on effective group participation, and the need for weekly simulation input increased the potential stress for students, while the teacher was faced with management of a simulation not previously used, and the adaptation of assessment tasks in line with student feedback.

The anticipated outcome was borne out by weaker student evaluations in the university's online survey (scaled 0-6) for the questions addressing assessment information (4.64), course component integration (4.92) and ongoing feedback (4.48).

Both student engagement and the students' perception of the development of graduate attributes were expected to respond positively to the introduction of the simulation. Questions addressing engagement and graduate attributes in the CATEI survey scored high ratings. The course was found to be interesting and challenging (5.12) effective for developing thinking skills (5.24) and students believed that they had learned a lot from the course (5.04). Overall results for the standard teaching and learning evaluation criteria were above the faculty average for the CATEI surveys in 2007 and 2008. The paper-based survey for this research produced similar results and the response rate was close to the last paper-based CATEI survey in 2006. (Table 1)

Once the survey results were collated, year on year survey responses were grouped (where matching questions allowed) into graduate attribute and course administration factors. The process was complicated by changes to questions and scales between CATEI surveys, but six questions were available compare. To adjust for the varying response scales, the percentage of responses received for 'Agree' type answers were aggregated.

Table 1: Teaching and learning criteria: Survey results

	Agree responses	Full time/Part time	Response rate
Subject survey 2008	96%		53%
CATEI survey 2008	92%	52% / 48%	35%
CATEI survey 2006	97%	100% / 0	56%

The chart (Fig 2) illustrates survey results for questions related to graduate attributes. More positive responses (substantially for Critical Thinking) were recorded, while the survey results for administrative issues declined as predicted. The fall was particularly evident in 'helpful feedback' where students were regularly encouraged to return to the simulation and discover what had happened in a decision cycle, rather than offered an immediate explanation by the teacher.

Additional questions on the paper-based subject survey addressed the simulation. Responses to these questions repeat the CATEI survey positive results for hypotheses 1 and 2. (Fig 1. scaled 0-4) and identified that the simulation task contributed strongly understanding of the subject (3.56). Free form responses included 19 positive comments tying use of the simulation to developing practical and 'real world' skills.

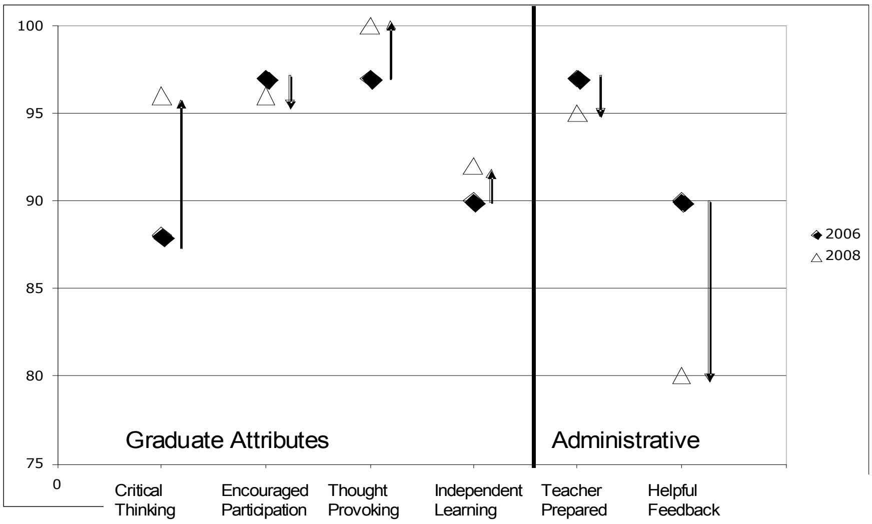

Figure 1: Survey results for graduate attributes and administrative issues

> Student 1: The simulation – by far one of the most beneficial assessments I have ever done in this course. I feel like I have a thorough knowledge of this subject as a result

> Student 2: The thing I liked most was the simulation which gave practical experience of the concepts being taught

The complexity of the simulation was considered appropriate (2.78) but the support materials and manuals were found to be lacking. Free form critical responses from students recommended provision of a longer learning phase with 2-3 trial decisions (consistent with the learning histories approach of Parush et al 2002), and corrections and adjustments to the simulation software – which have been forwarded to the vendor. Preparation and pre-training for the simulation remains an area of focus in developing the subject, and opportunities to prepare students in earlier prerequisite courses will be explored.

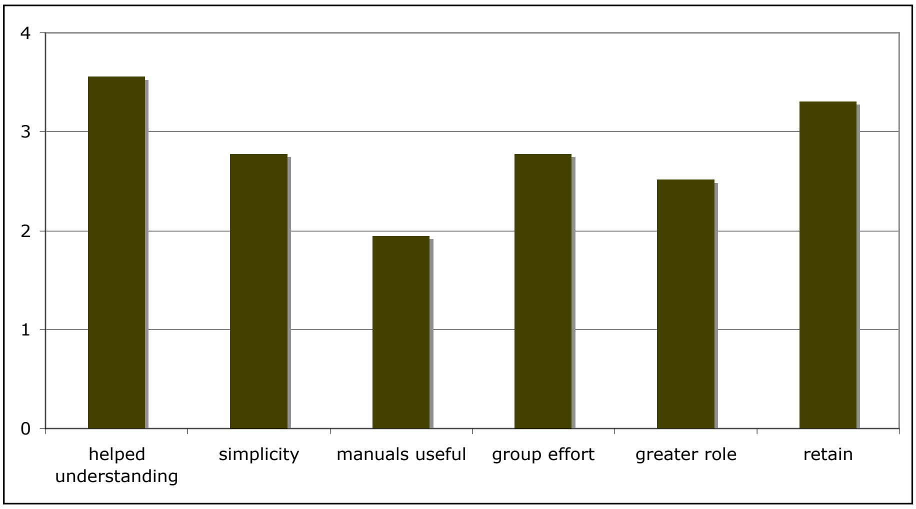

Figure 2: Student survey responses: Simulation specific questions

The survey score of 2.78 for group effort was higher than expected, given the high degree of group interaction required to run the simulation. To maximise the group experience, the class was allowed to self-select groups of 5-7students in the first week of the semester. Group enrolment was managed through web-CT. Peer reviews, in-class tasks, and a requirement for full group attendance at a minimum of two group-lecturer meetings through the semester helped to keep group engagement high and avoid 'passengers' riding on the group effort. Groups were actively encouraged to construct a management team, and to split responsibilities for a range of management tasks including scheduling, finance, engineering, and marketing. Final business plan presentations were assessed, and groups were asked to split the business into geographic regions, assuring that all group members were engaged in the preparation and presentation of a portion of the final report.

Moving forward

There is an element of risk faced incorporating simulation learning tools into undergraduate programs. Greater teacher involvement is required to manage the activities, much more can go wrong with a web-based simulation than a PowerPoint presentation or case-study, and there is the likelihood that aligning the learning objectives with graduate attributes will make students feel less comfortable and less certain. Where the teacher's performance evaluation is linked to student survey results there are incentives not to push boundaries.

The positive student feedback identified on factors related to graduate attributes supports implementing an experiential learning approach, and the potential integration of a simulation as a learning tool. Simulations cannot replace didactic content, but can offer an opportunity to stretch students and to better align their learning experience with the desired outcomes. Approaches to reduce the administrative 'risk' element of simulations can include opportunities for 'pre-learning' the software, including the development of learning history, explicit linkage of prior subject learning to the simulation objectives, and more intensive focus on feedback early in the course.

An added benefit is greater integration of the aviation program, achieved by carrying forward the output of the completed simulation to the subsequent resource management subject. This allows students to further reflect on earlier learning while applying new concepts to the end result of their simulation. Opportunities will be explored to extend this integrated learning approach throughout the aviation program.

Looking more broadly, teachers moving to incorporate simulations in undergraduate management subjects need support to manage the administrative load and the greater risks encountered. Students engaging with the simulation are likely to feel less comfortable despite acknowledging a better learning experience. Aligning student learning with graduate attributes should be a given of course design, and simulations have an apparent role to play in achieving alignment. Further research is proposed to identify options for better integration of the simulation in the 3 year program, more effective pre-learning for students, and greater acceptance of the discomfort of experiential learning as students work though the Kolb cycle.

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